

**Magnesium plus Calcium to Bicarbonate**

The areal distribution of the milliequivalent ratio of magnesium plus calcium to bicarbonate ( $MgCa/HCO_3$ ) in water from permeable zone E ranges from less than 0.1 in the mid-dip area between the Sabine arch and the Mississippi River to 1.140 in an area between mid-dip and the downdip limit of the data in southern Texas (table 1). The  $MgCa/HCO_3$  ratio generally decreases from the outcrop to the downdip limit of the data in the area between the Sabine arch and the Mississippi River and in the area between the San Marcos arch and the Rio Grande (fig. 17). The  $MgCa/HCO_3$  ratio generally increases from the downdip limit and decreases from mid-dip to the downdip limit of the data in the area between the Sabine arch and the San Marcos arch (fig. 17).

From the Mississippi River eastward to the western edge of Florida the  $MgCa/HCO_3$  ratio generally ranges from 0.05 to 1 in both the outcrop and area between the outcrop and the downdip limit of the data. From the Mississippi River westward to the Sabine arch the ratio generally ranges from 0.05 to 0.1 in the outcrop and area between the outcrop and the downdip limit. From the outcrop to mid-dip the ratio ranges from 0.1 to 0.5 and increases in a downdip direction to more than 50 in two areas near the downdip limit of the permeable zone (fig. 17).

From the Sabine arch westward to the San Marcos arch the  $MgCa/HCO_3$  ratio is about 1 in the outcrop and decreases to 20 at mid-dip and increases to the downdip limit of the permeable zone, the ratio increases to 50 midway between mid-dip and downdip and decreases to 1 near the downdip limit of the permeable zone (fig. 17). From the San Marcos arch westward to the Rio Grande the  $MgCa/HCO_3$  ratio ranges from about 0.1 in the outcrop area to 20 at mid-dip. From mid-dip to the downdip limit of the data the ratio decreases to 5 but there are several localized areas of 50 and one of 1.

**Magnesium plus Calcium to Sodium plus Potassium**

The areal distribution of the milliequivalent ratio of magnesium plus calcium to sodium plus potassium ( $MgCa/NaK$ ) in water from permeable zone E ranges from less than 0.01 near the downdip limit of the data in southern Texas to 0.9 near the outcrop and area between the outcrop and the downdip limit of the data (table 1). The  $MgCa/NaK$  ratio generally decreases from the outcrop to the downdip limit of the data in the area between the Sabine arch and the Mississippi River and in the area between the San Marcos arch and the Rio Grande (fig. 18). No trend is indicated in the area from the Sabine arch eastward to the western edge of Florida.

From the Sabine arch westward to the San Marcos arch the  $MgCa/NaK$  ratio is about 1 in the outcrop and decreases to 10 in the outcrop and area between the outcrop and the downdip limit of the data except for a localized area in the outcrop where the ratio is 20. From the San Marcos arch westward to the Rio Grande the ratio ranges from 0.1 in the area along the downdip limit of the data to 2 in a small localized area in the outcrop near the Brownsville River.

**Bicarbonate to Sulfate**

The areal distribution of the milliequivalent ratio of bicarbonate to sulfate ( $HCO_3/SO_4$ ) in water from permeable zone E ranges from 0.01 near the downdip limit of the data in southern Texas to 720 at the downdip limit of the data in southern Mississippi (table 1). The  $HCO_3/SO_4$  ratio shows no trend but varies randomly across the area of permeable zone E (fig. 19).

From the Sabine arch eastward to the western edge of Florida the  $HCO_3/SO_4$  ratio ranges from 5 to 100 in both the outcrop and area between the outcrop and the downdip limit of the data. From the Sabine arch westward to the Rio Grande the ratio generally ranges from 5 to 10 in the outcrop and in the area from the outcrop to the downdip limit of the data except for a localized area in the outcrop area where the ratio is 20. From the San Marcos arch westward to the Rio Grande where the ratio is small and appears to have no trend (fig. 20).

From the Mississippi River eastward to the western edge of Florida the  $HCO_3/Cl$  ratio generally ranges from 2 to 200 in both the outcrop and area between the outcrop and the downdip limit of the data. From the Mississippi River westward to the Sabine arch the ratio generally ranges from 1 to 100 in the outcrop and in the area from the outcrop to mid-dip and decreases to less than 0.01 along the downdip limit of the permeable zone.

From the Sabine arch westward to the San Marcos arch the  $HCO_3/Cl$  ratio generally ranges from 1 to 2 in both the outcrop area and the area between the outcrop and mid-dip. From the mid-dip area between the outcrop and the downdip limit of the data to about 0.01. From the San Marcos arch southward to the Rio Grande the  $HCO_3/Cl$  ratio generally ranges from 0.01 to 0.1 in both the outcrop area and the area from the outcrop to the downdip limit of the data.

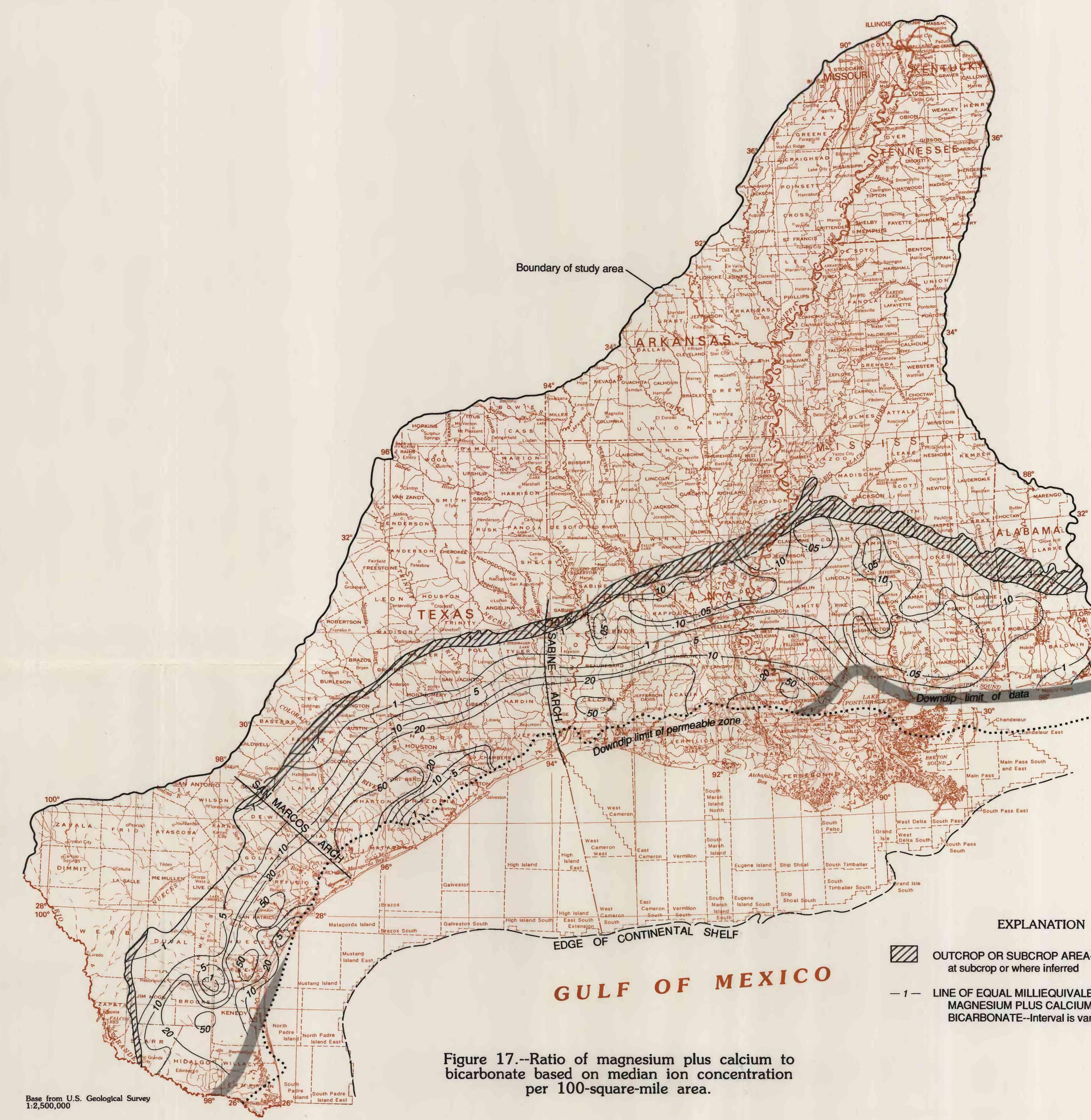


Figure 17.—Ratio of magnesium plus calcium to bicarbonate based on median ion concentration per 100-square-mile area.

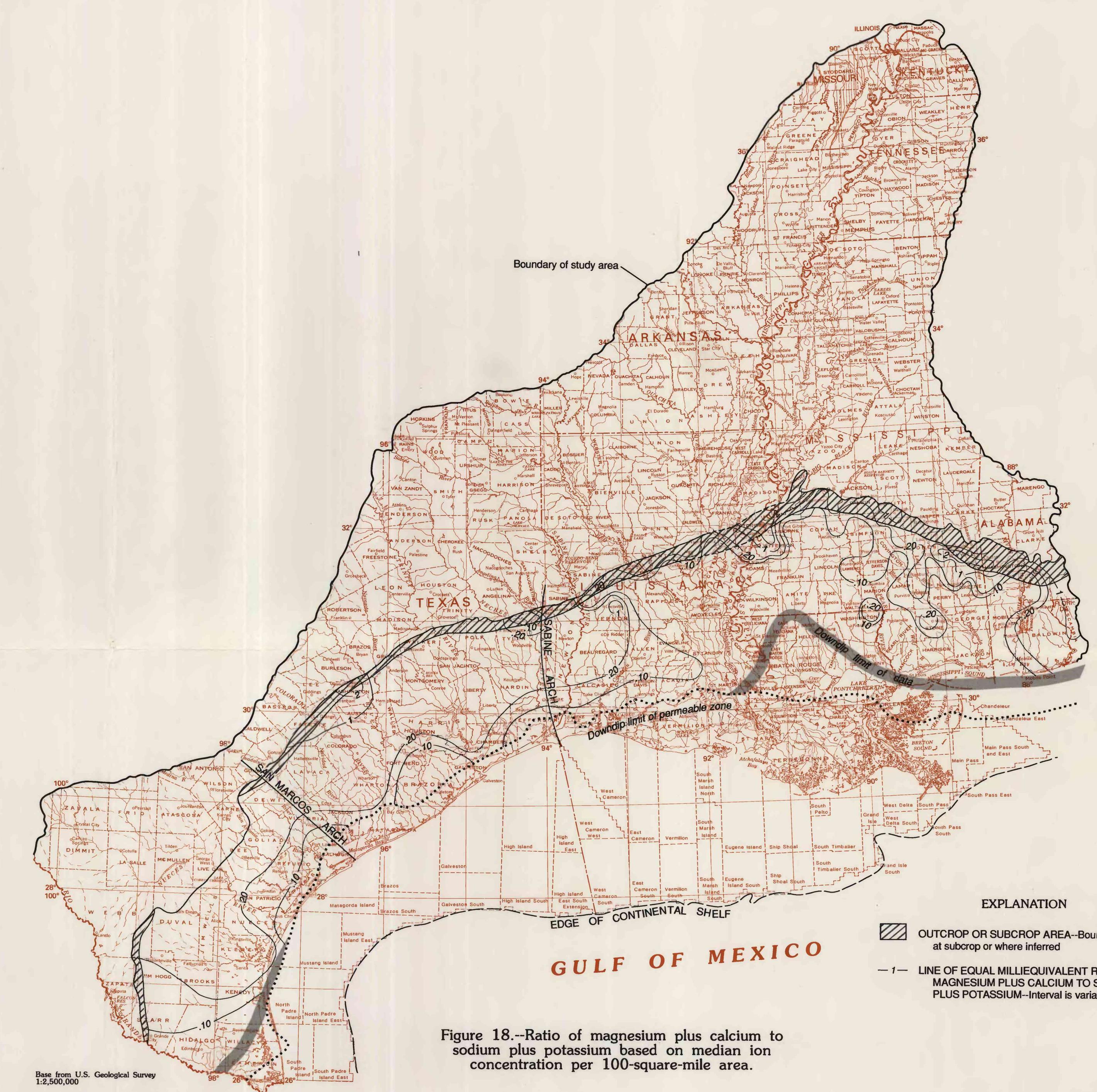


Figure 18.—Ratio of magnesium plus calcium to sodium plus potassium based on median ion concentration per 100-square-mile area.

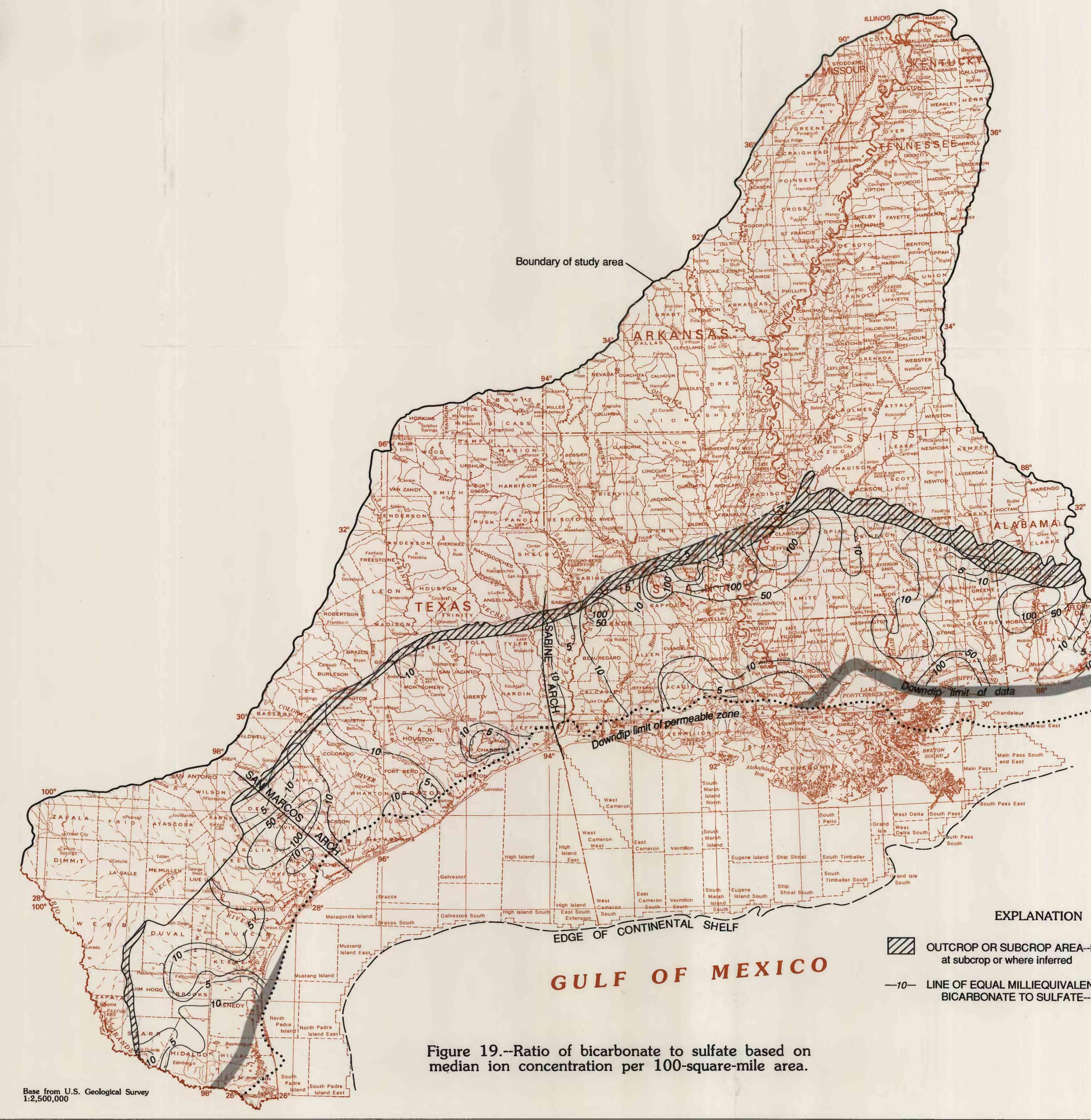


Figure 19.—Ratio of bicarbonate to sulfate based on median ion concentration per 100-square-mile area.

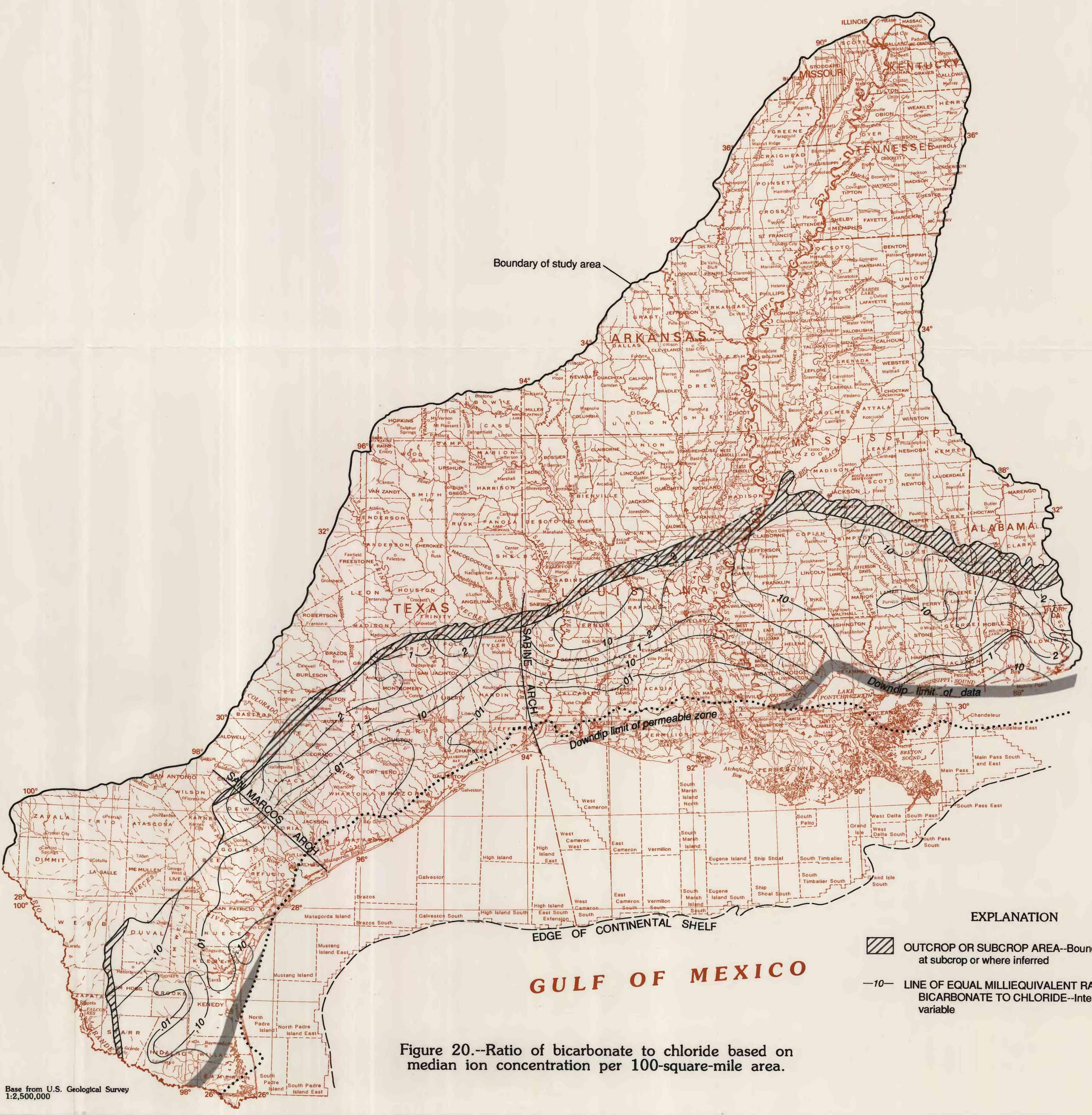


Figure 20.—Ratio of bicarbonate to chloride based on median ion concentration per 100-square-mile area.

## PROPERTIES AND CHEMICAL CONSTITUENTS IN GROUND WATER FROM PERMEABLE ZONE E (LOWER MIocene-UPPER OLIGOCENE DEPOSITS), COASTAL LOWLANDS AQUIFER SYSTEM, SOUTH-CENTRAL UNITED STATES

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